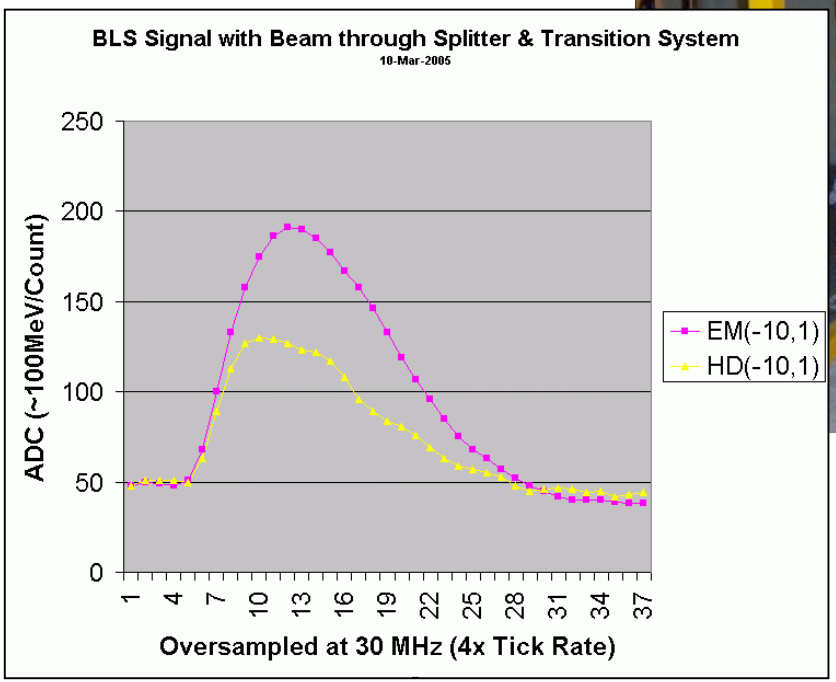
Run IIb L1 CAL Trigger Upgrade

- Motivation
- Overview
- Components
- Organization



Motivation and Goals

4 Level 1 Calorimeter Trigger

4.1 Goals

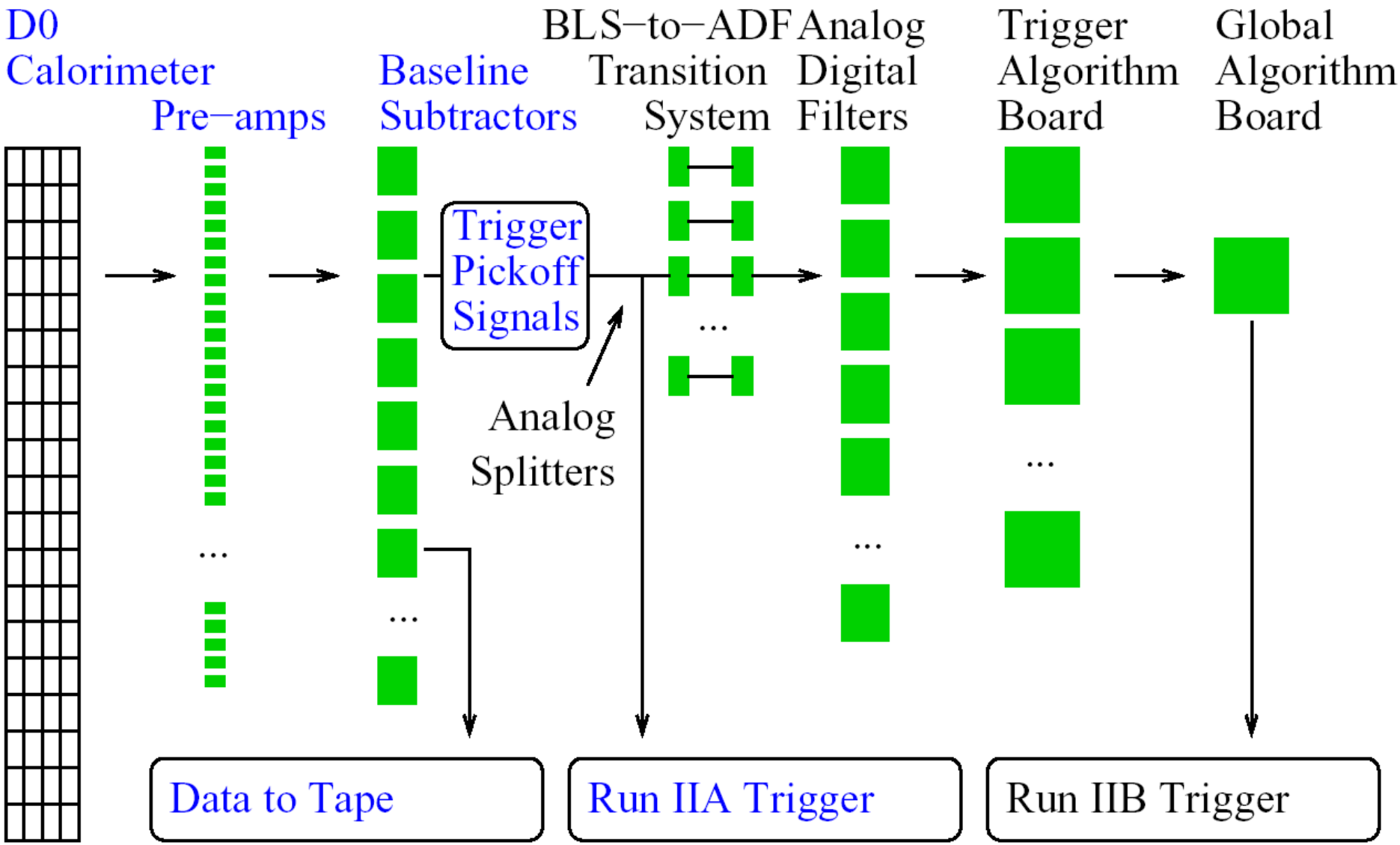
The primary focus of Run IIb will be the search for the mechanism of electroweak symmetry breaking, including the search for the Higgs boson, supersymmetry, or other manifestations of new physics at a large mass scale. This program demands the selection of events with particularly large transverse momentum objects. The increase in luminosity (and thus increasing multiple interactions), and the decreased bunch spacing (132ns) for Run IIb will impose heavy loads on the Level 1 (L1) calorimeter trigger. The L1 calorimeter trigger upgrade should provide performance improvements over the Run IIa trigger system to allow increased rejection of backgrounds from QCD jet production, and new tools for recognition of interesting signatures. We envision a variety of improvements, each of which will contribute to a substantial improvement in our ability to control rates at the L1 trigger. In the following sections we describe how the L1 calorimeter trigger upgrade will provide

- An improved capability to correctly assign the calorimeter energy deposits to the correct bunch crossing via digital filtering
- A significantly sharper turn-on for jet triggers, thus reducing the rates
- Improved trigger turn-on for electromagnetic objects
- The ability to make shape and isolation cuts on electromagnetic triggers, and thus reducing rates
- The ability to match tracks to energy deposition in calorimeter trigger towers, leading to reduced rates
- The ability to include the energy in the intercryostat region (ICR) when calculating jet energies and the missing ET
- The ability to add topological triggers which will aid in triggering on specific Higgs final states.

The complete implementation of all these improvements will provide us with the ability to trigger effectively with the calorimeter in the challenging environment of Run IIb.

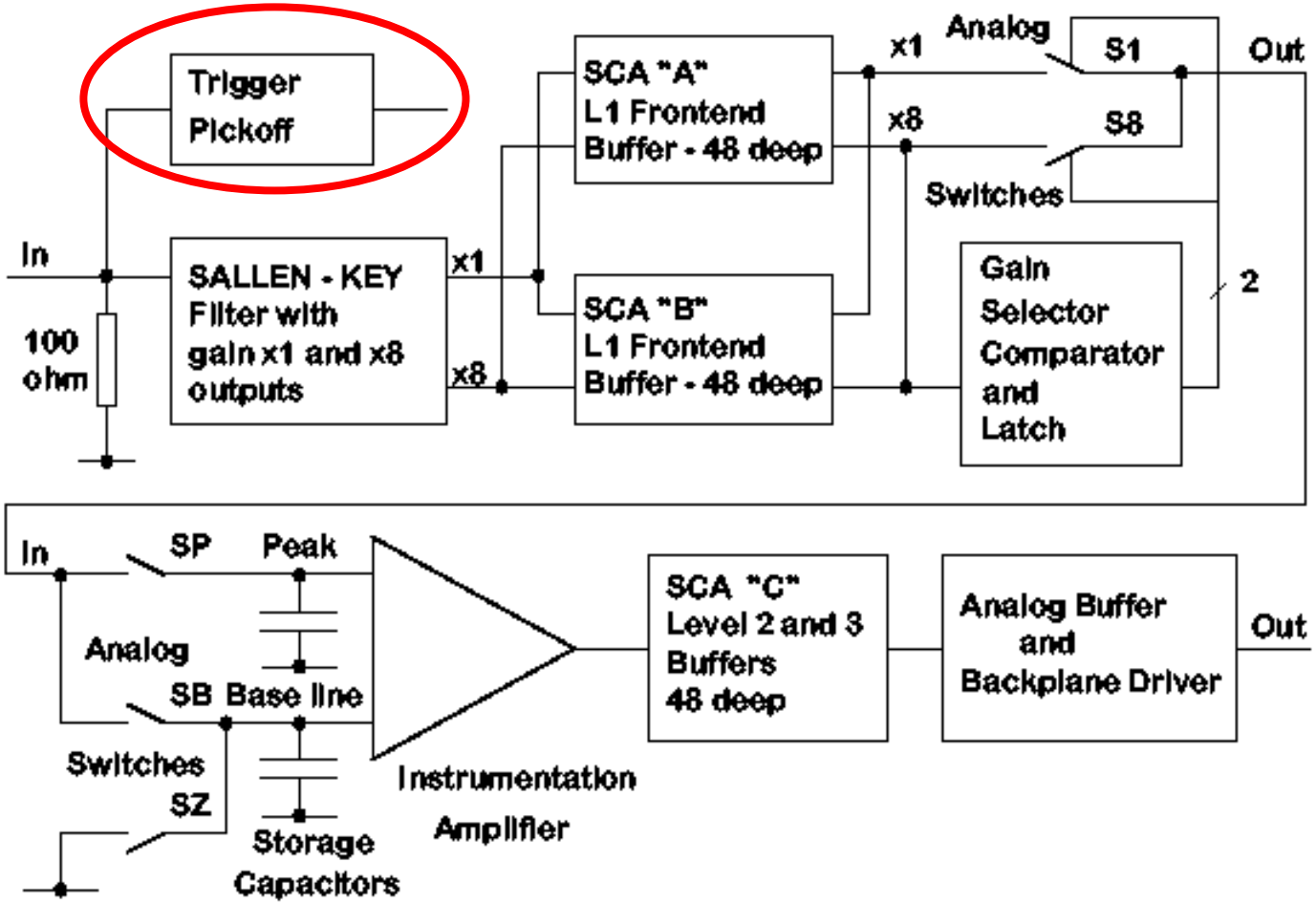
Technical Design Report Pg 317

L1 CAL Trigger Overview



M. Mulhearn (2005)

Baseline Subtractor

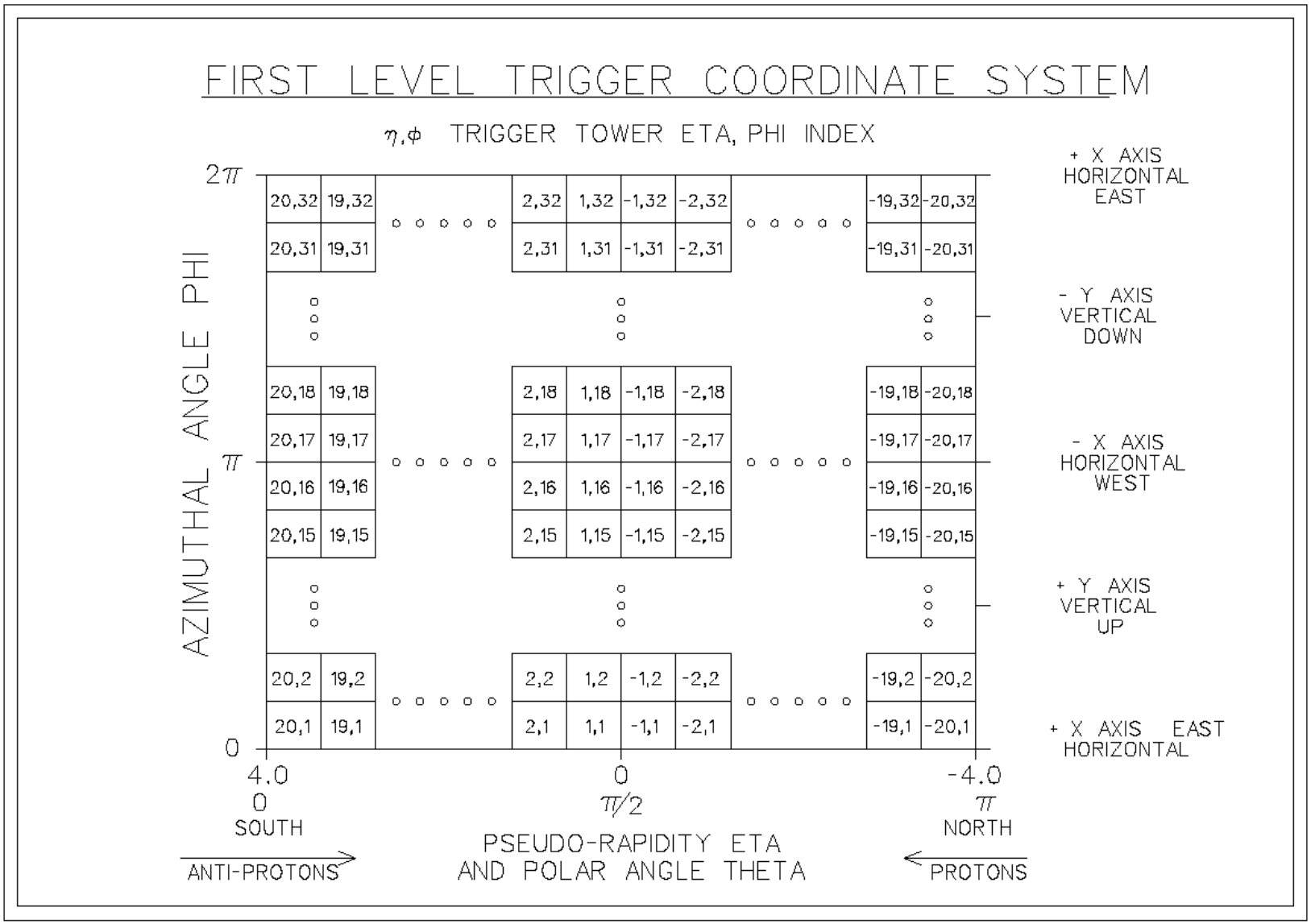


Schematic of the BLS system showing the precision readout path and the location of the calorimeter trigger pickoff signal.

L1 CAL Trigger Signal

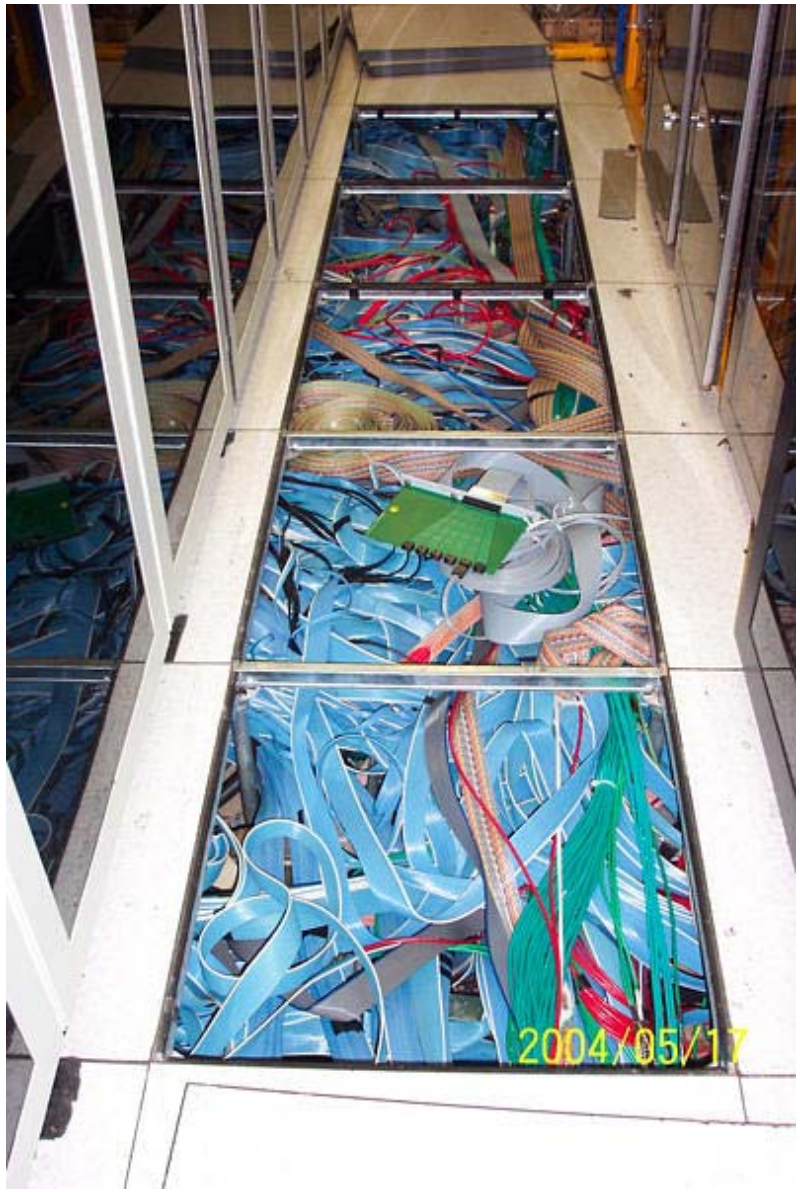
- The trigger pickoff of the Calorimeter signal takes place on the Baseline Subtactor (BLS) cards on the platform
  - There are 1280 BLS cards each with up to 48 channels of physics readout : 2 η x 2 φ x 12 depth (EM & Hadronic layers)
- The signals from the EM and Hadronic layers are added with the appropriate weights to form the analog trigger sums and passed through trigger summer drivers
  - There are 2560 such drivers - one for each of the 1280 Trigger Towers (TT) EM and Hadronic component
- These analog sums are transported differentially to the L1 Calorimeter Trigger electronics to the first floor of the Moveable Counting House
  - Each TT (EM+,EM-,HD+,HD-) signal is then carried along four consecutive coaxial cables to MCH1 and distributed among ten racks (M103-M112)
- The trigger eta & phi has a factor of two larger granulation than the precision readout (physics) eta and phi
- Each rack receives as inputs TT cables from all phi for a consecutive group of eta (1:4, -1:4, 5-8…)

Calorimeter Trigger Coordinate System



Existing L1 CAL Trig Electronics

BLS Trigger Cables

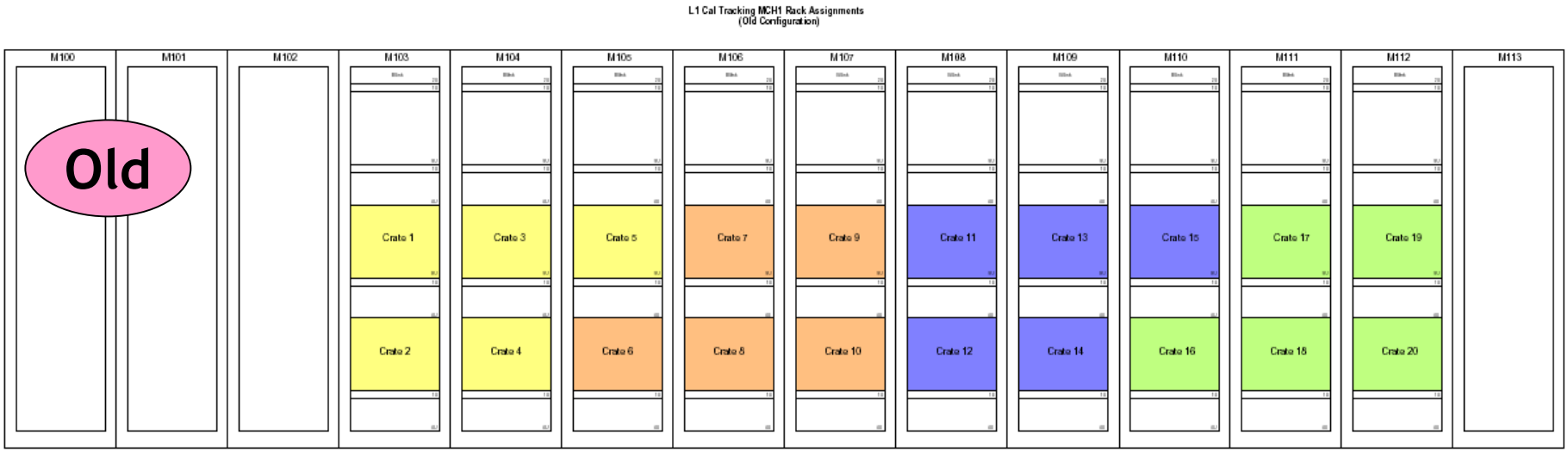


- 78 & 80 Ohm impedance
  - Two different manufacturers
  - Installed at the beginning of Run I
- 130 feet to North End-Cap Calorimeter [EC]
- 150 feet to Central Calorimeter [CC]
- 180 feet to South End-Cap Calorimeter [EC]
- Congested space beneath floor boards

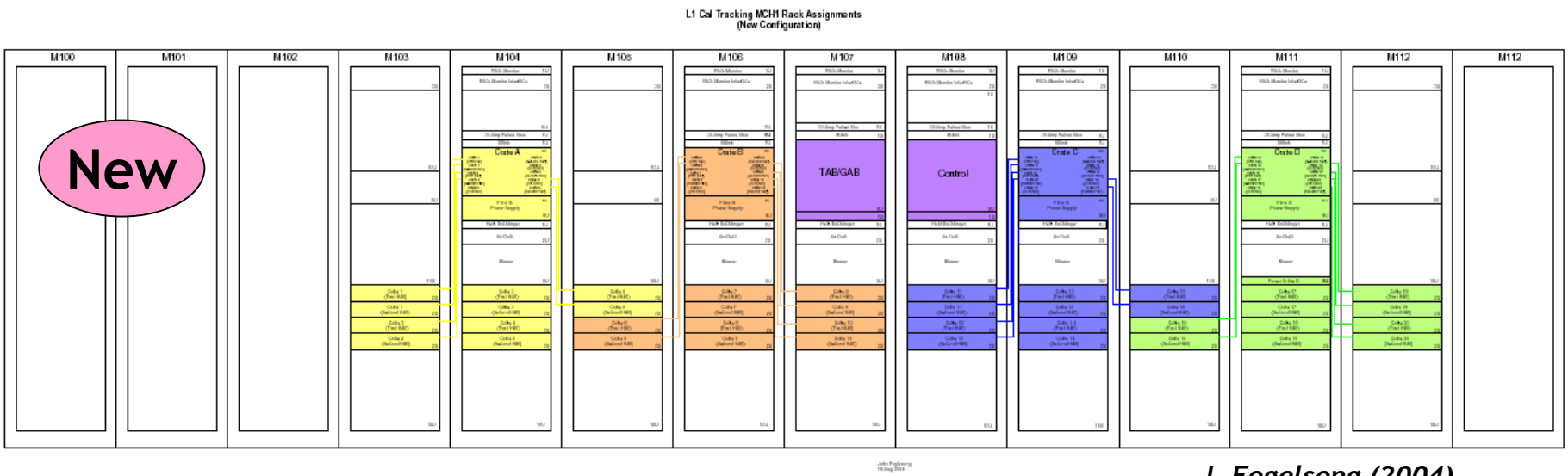
Existing MCH Rack (x10)

- Within each rack, there are 128 TT cables
  - We have pursued a design which does not require rerouting the BLS cables
- Four patch panels per rack
  - Passive electronics
  - Input: 32 TT cables/patch panel
  - Output: 2 ADF boards
- Protection System and Cooling
  - 6 of 10 racks
    - 4 racks contain only patch panels
  - Rack Monitor, RMI, Remote controlled Pulizzi Box, Smoke & Drip Detectors
  - Blower, Heat Exchanger & Fan
- Plan on reusing racks as well
  - Strip out racks to frames
  - BLS cables are routed externally among cable guides
    - Will only need to disconnect cables from boards

MCH Configuration

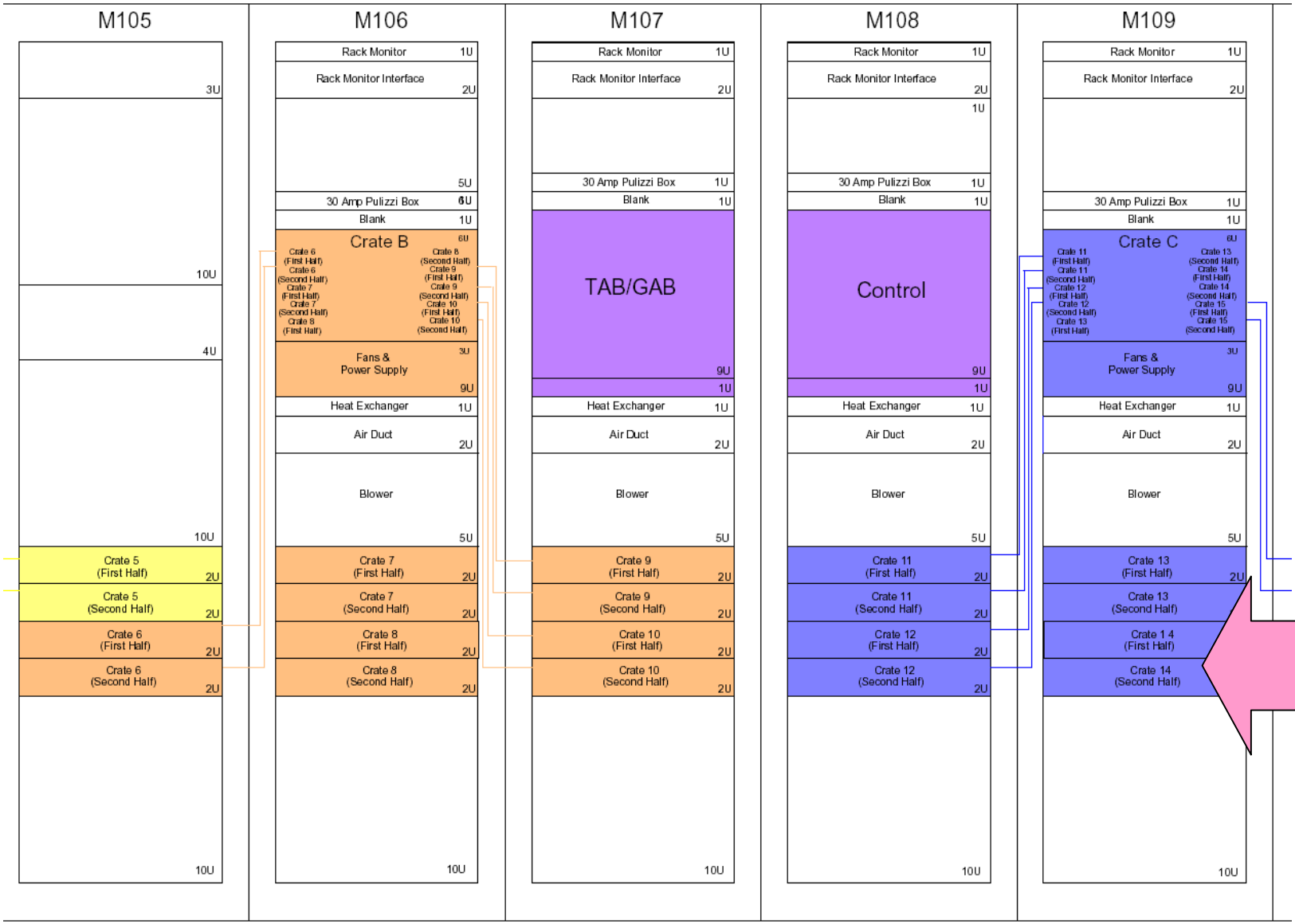


Color coding illustrates the old & new TT readout.

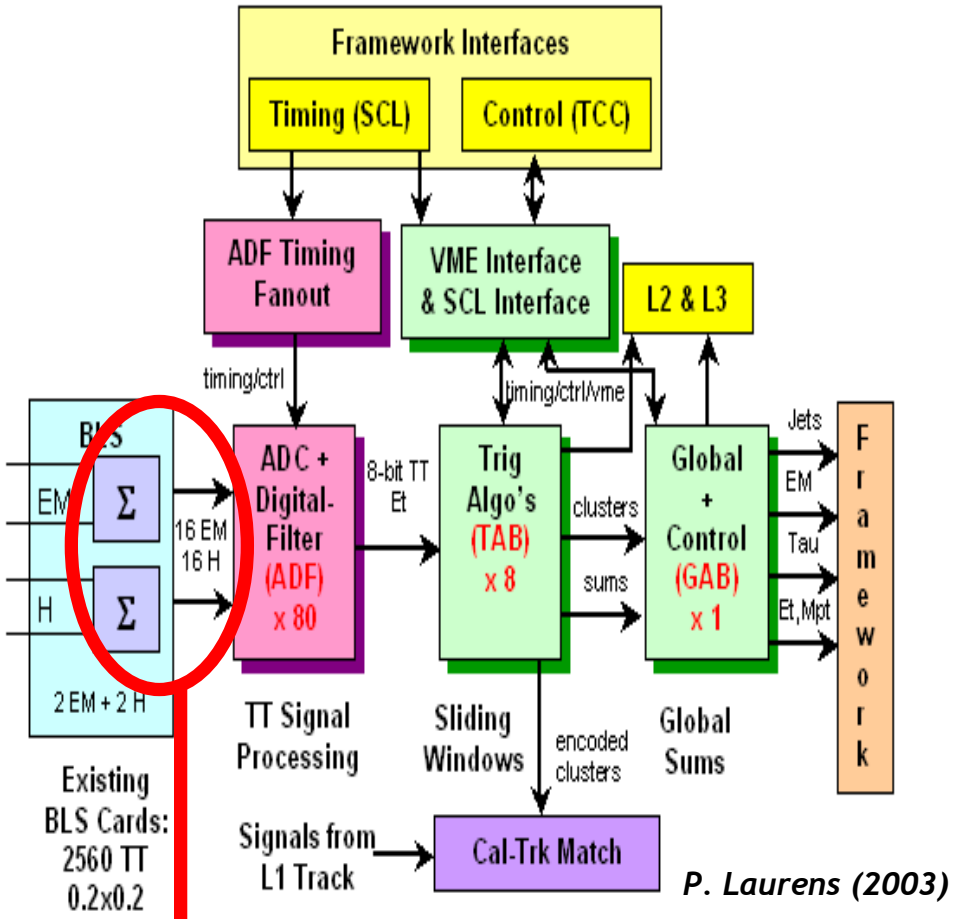


J. Fogelsong (2004)

Run IIb MCH1 Rack Layout



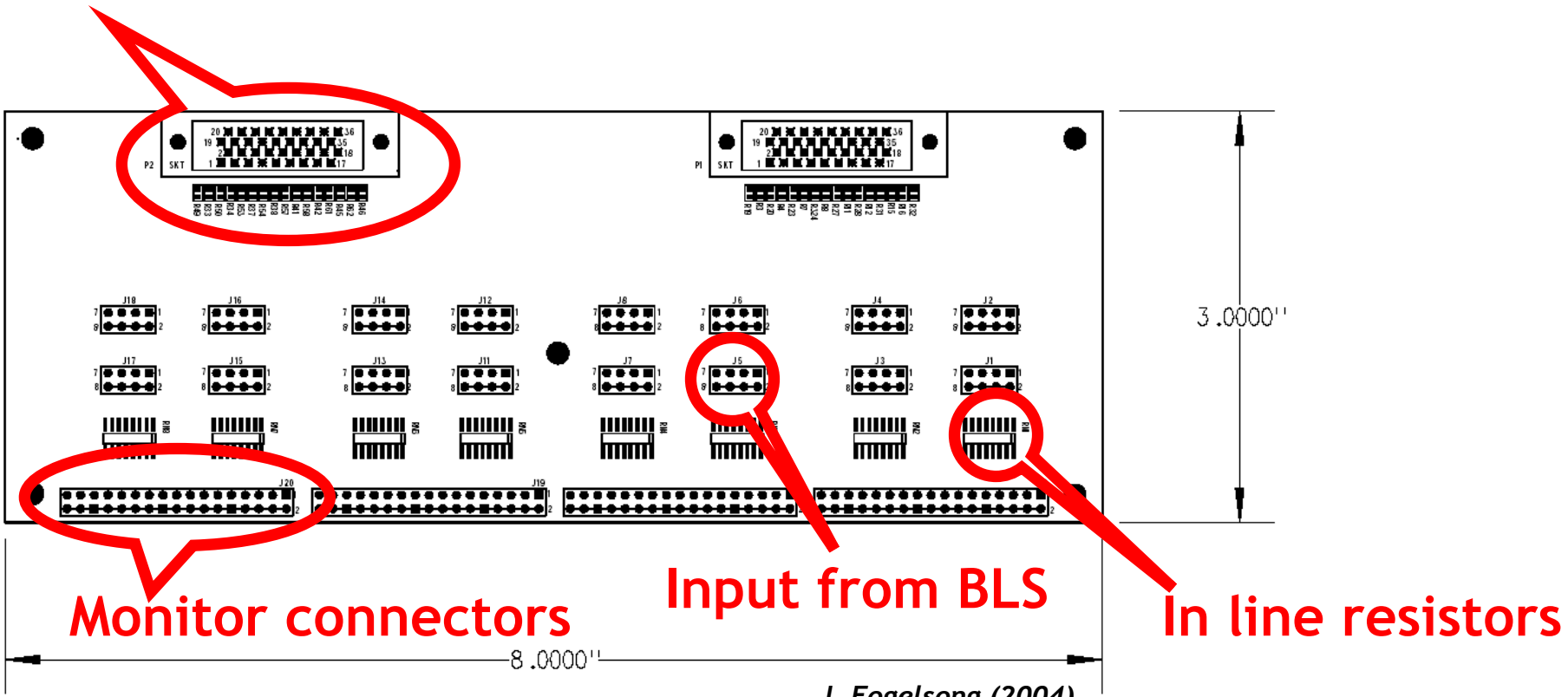
BLS-to-ADF Transition System



How do we get the signals from the existing cables to the new electronics?

- The BLS trigger cables will be reused for the upgrade
  - Cannot replace or reroute them!
- New electronics are more compact
  - 4 crates (new) vs 20 crates (old)
- Connector mismatch
  - Cannot plug 8-pin BLS connectors directly into 20-pin ADF connectors (on backplane)
- Cable access & channel debugging
  - Plug in scope during physics data taking without disconnecting cables
  - Disentangle problems pre- and post-ADF crates
- Preserve signal integrity
  - Noise, reflection, timing, etc. are all concerns
- Build & test independently
  - We do not need the ADF or TAB systems

Patch Panel Card (x80)

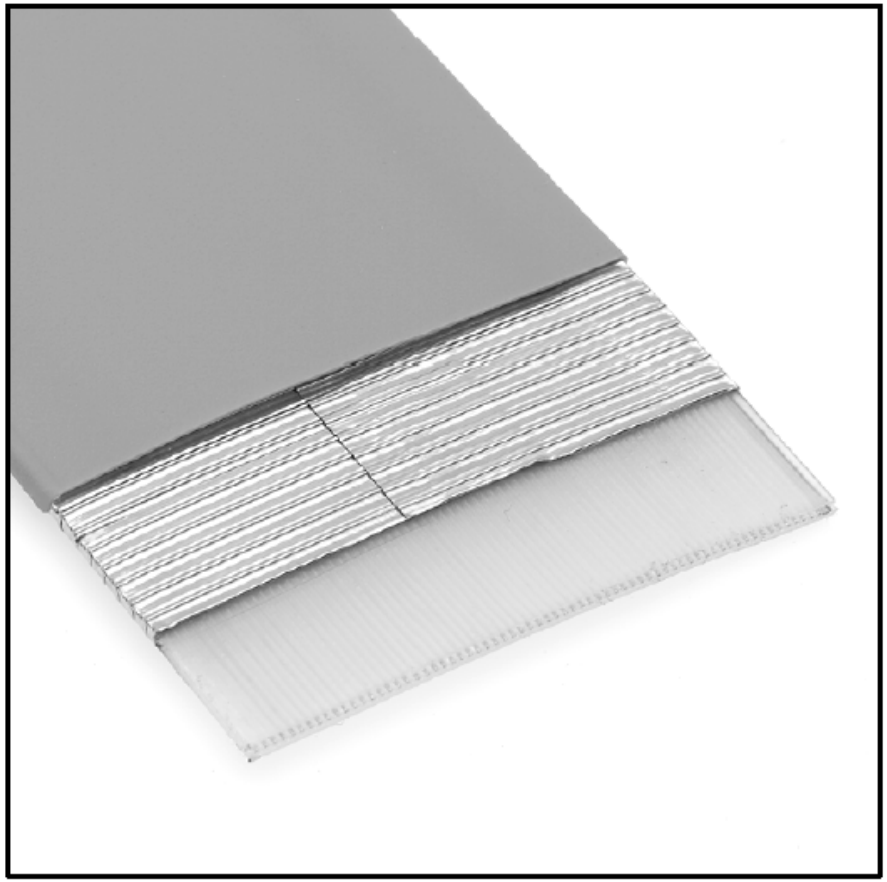


Two patch panel cards - stuffed printed circuit boards - mounted to each patch panel. Only the monitor connectors are visible from the front of the patch panel. Cables are connected from the back.

Pleated Foil Cable (x160)

3M™ Pleated Foil Shielded Cable

.025″ 30 AWG Solid, TPE Primary, TPE Cover 90211 Series



- Can be used with IDC mass termination connectors
- Can be used in applications requiring standard impedance of 75 ohms single ended
- Extremely low crosstalk, used in the all signal mode to quadruple signal density as compared to standard .050 inch flat ribbon cable
- Perfect for board-to-board applications within electronic equipment, TPE cover prevents pleated copper foil from accidental shorting
- Solid pleated copper foil provides flexibility and 35 db average shielding effectiveness

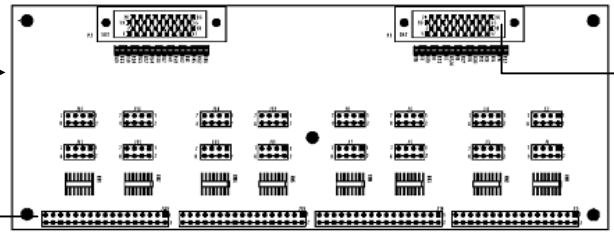
Date Modified: May 30, 2003

TS-0598-08
Sheet 1 of 2

Good impedance match to BLS trigger cables. Need two pleated foil cables to carry TT signals from each patch panel card to the ADF board.

BLS-to-ADF Signal Path

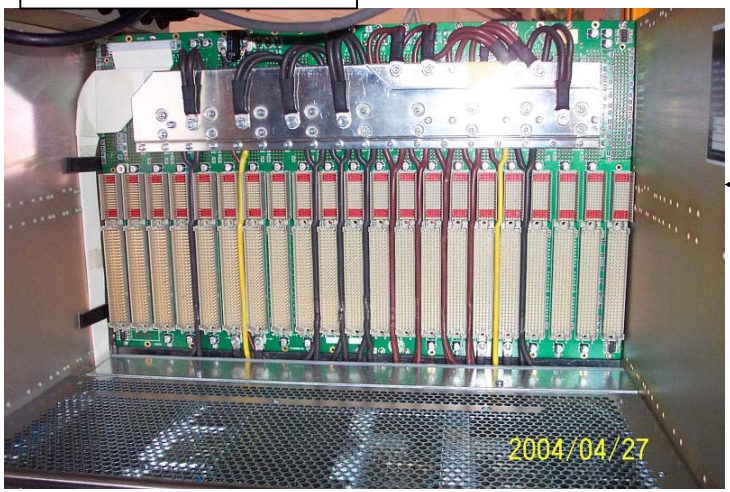
Patch Panel Card (2 per Patch Panel)
16 BLS trigger cable inputs
2 Pleated Foil Cable outputs to one Paddle Card



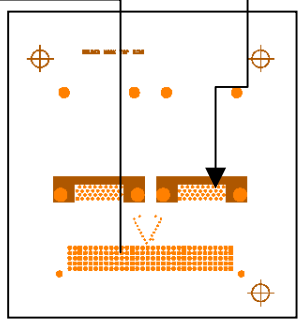
Scope

D0 Note 4692
Impedance Matching and Frequency Analysis of the BLS Trigger and Pleated Foil Cables

ADF Backplane



3M Pleated Foil Cables

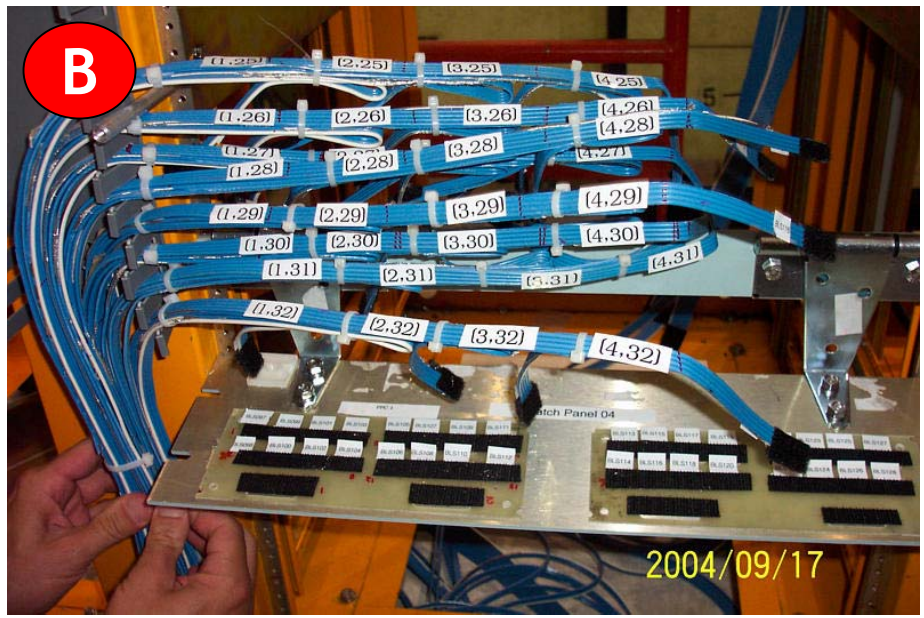


Paddle Card (1:1 to ADF cards)
2 Pleated Foil Cables inputs from one Patch Panel Card
One ERNI connector output to the ADF backplane

Mock-up

Making a mock-up of existing BLS trigger cables as similar as possible.

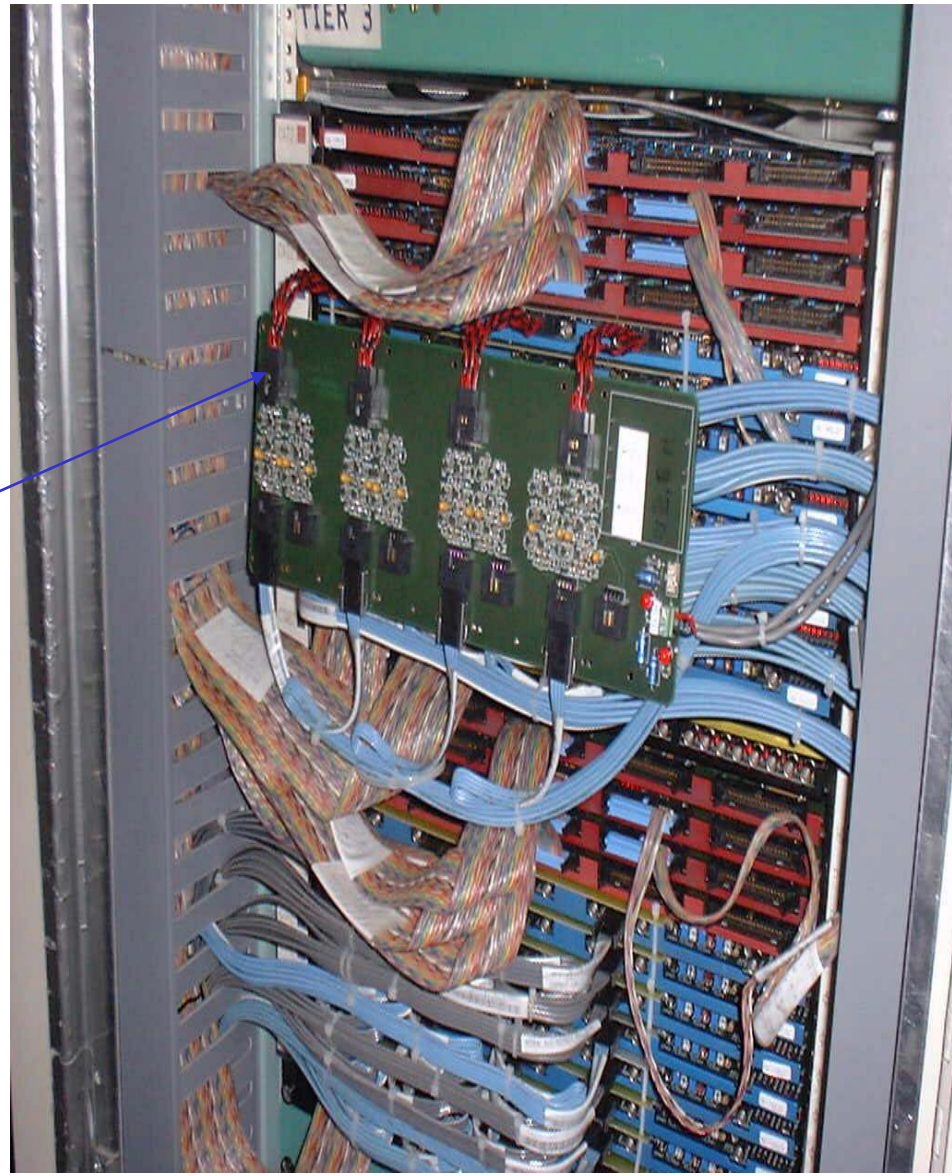
- A wise man advised me that most problems with cabling are mechanical not electrical
  - Strain relief & volume flow
  - Connectorization
  - Labelling
- Take the time now to figure out how to go from A to B
  - We won't have the luxury of time next year



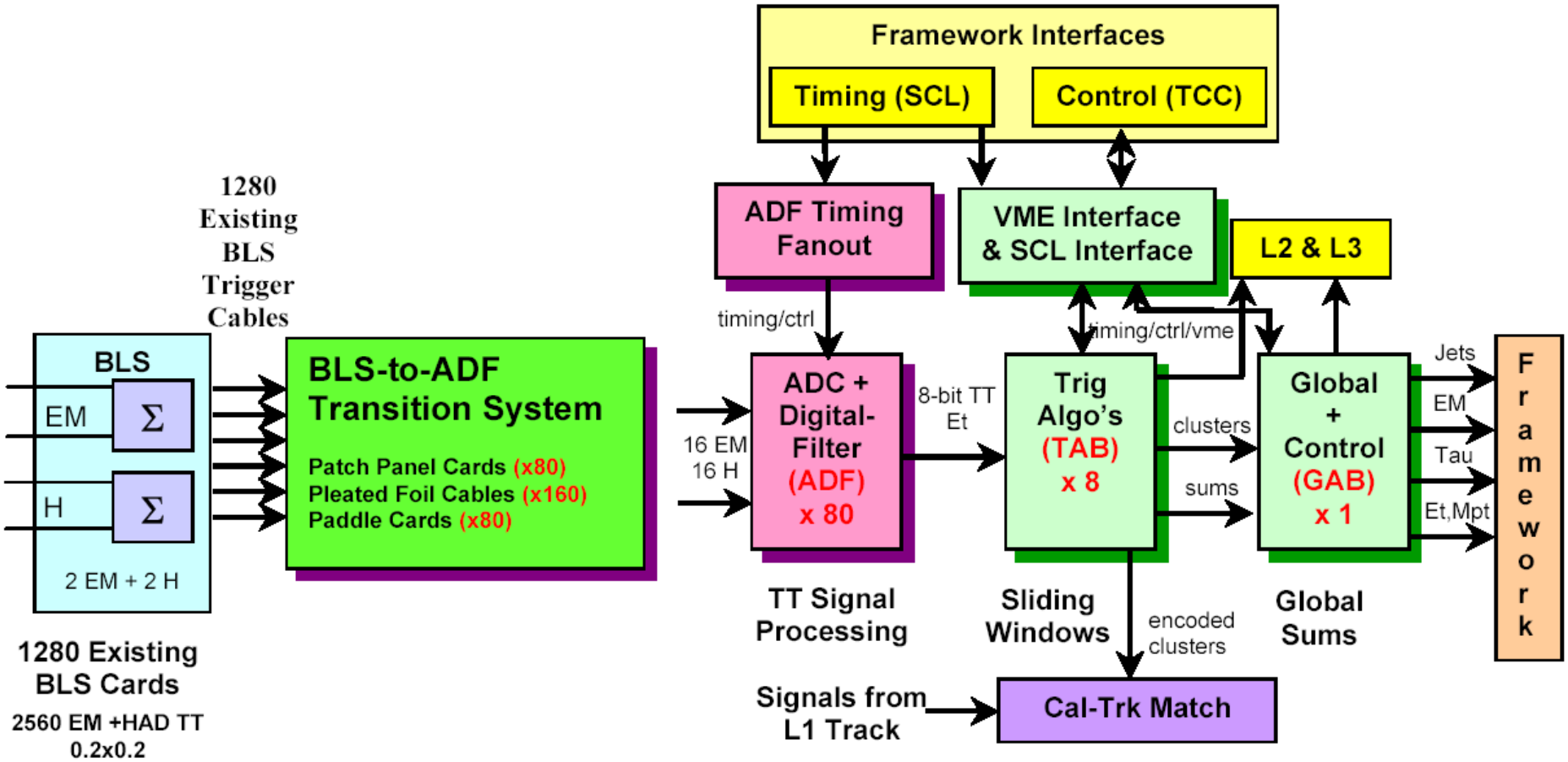
- This was not easy!
  - Went through five iterations
- Validating channel map
  - Better to find mistakes now
- Procedure documented in a D0 Note (nearly finished)
  - Incorporate engineering changes to patch panels

BLS Trigger Signal Splitter

- Access to Real TT Data using "Splitter" Boards
  - designed/built by Saclay
  - active split of analog signals at CTFE input
  - 4 TTs per board
- Splitter Data
  - no perturbation of Run IIa L1Cal signals
  - allows tests of digital filter algorithm with real data
- BUT
  - At best, we will be able to install 4-5 splitters, for a total of 16-20 TTs (out of 1280)
  - Still useful to compare new and old TT data offline (physics, zero bias or pulser)

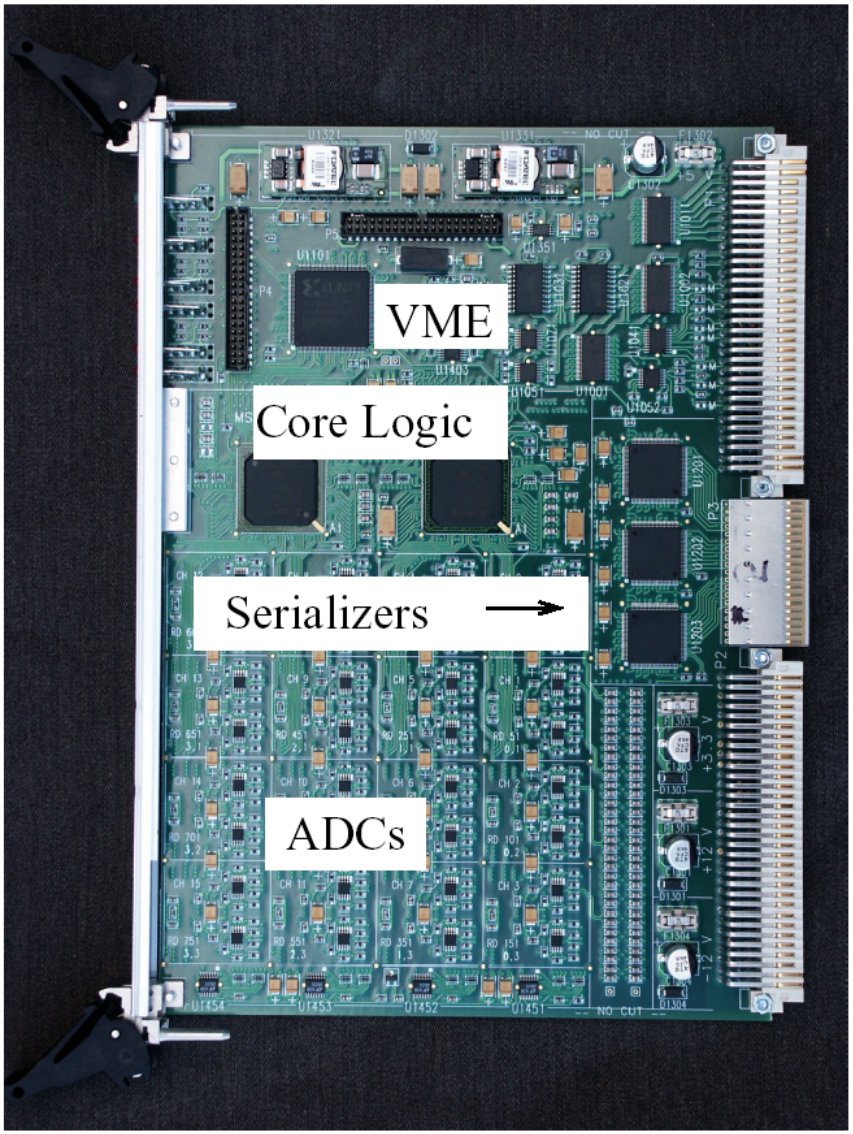


Run IIb L1 CAL Trigger Signal Path



In the next few slides, I will give a "slide-show" of the new electronics.

Analog Digital Filter Boards (x80)



VME
Board Control

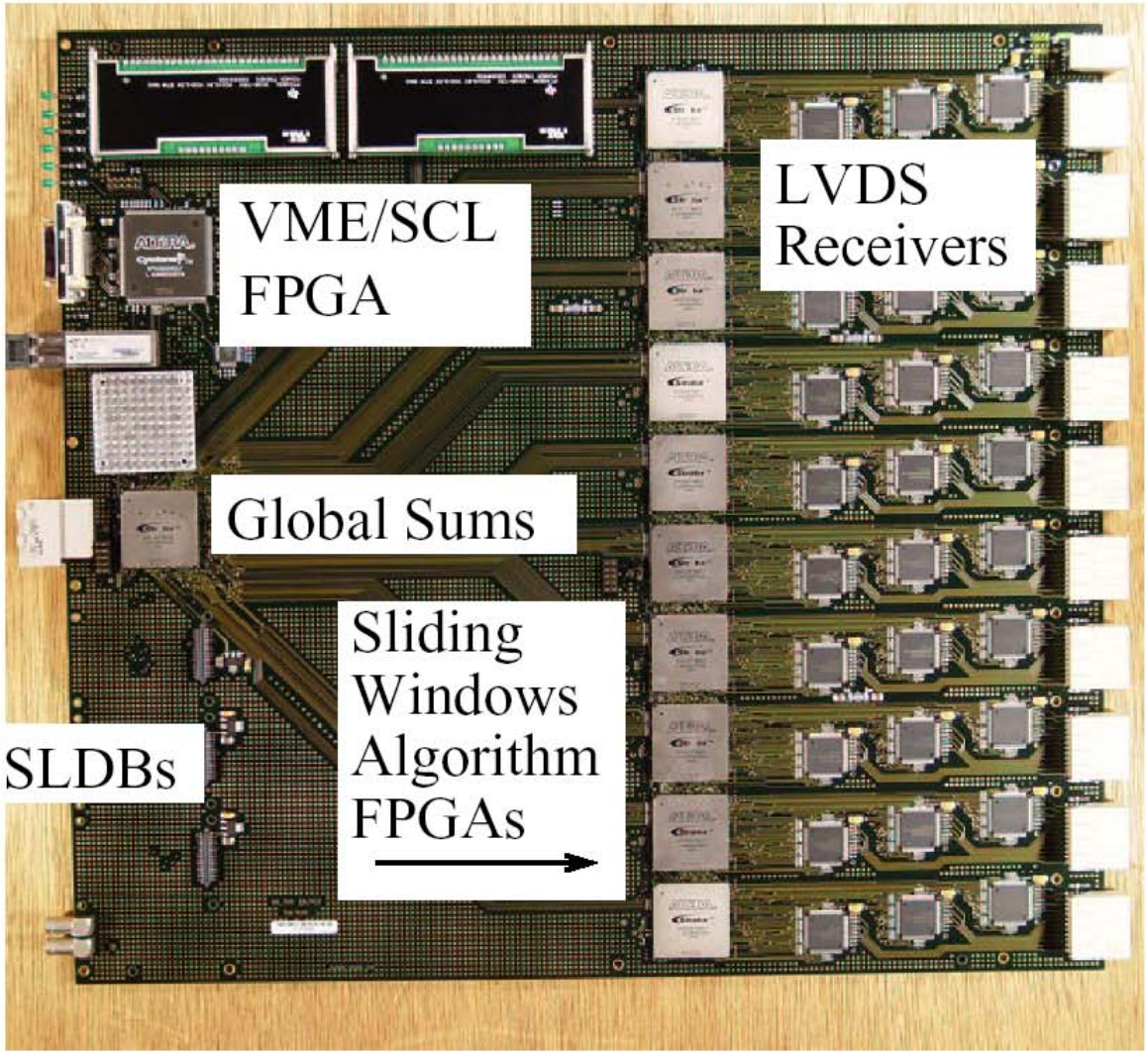
Serial
Digital Out
Trigger Towers

Trigger
Algorithm
Boards
(TAB)

Analog In
Trigger
Pickoff
Signals

Baseline
Subtractors
(BLS)

Trigger Algorithm Board (x8)



LEDs

VME/SCL

L2/L3

Output to Global Algorithm Board

Cal–Trk Match

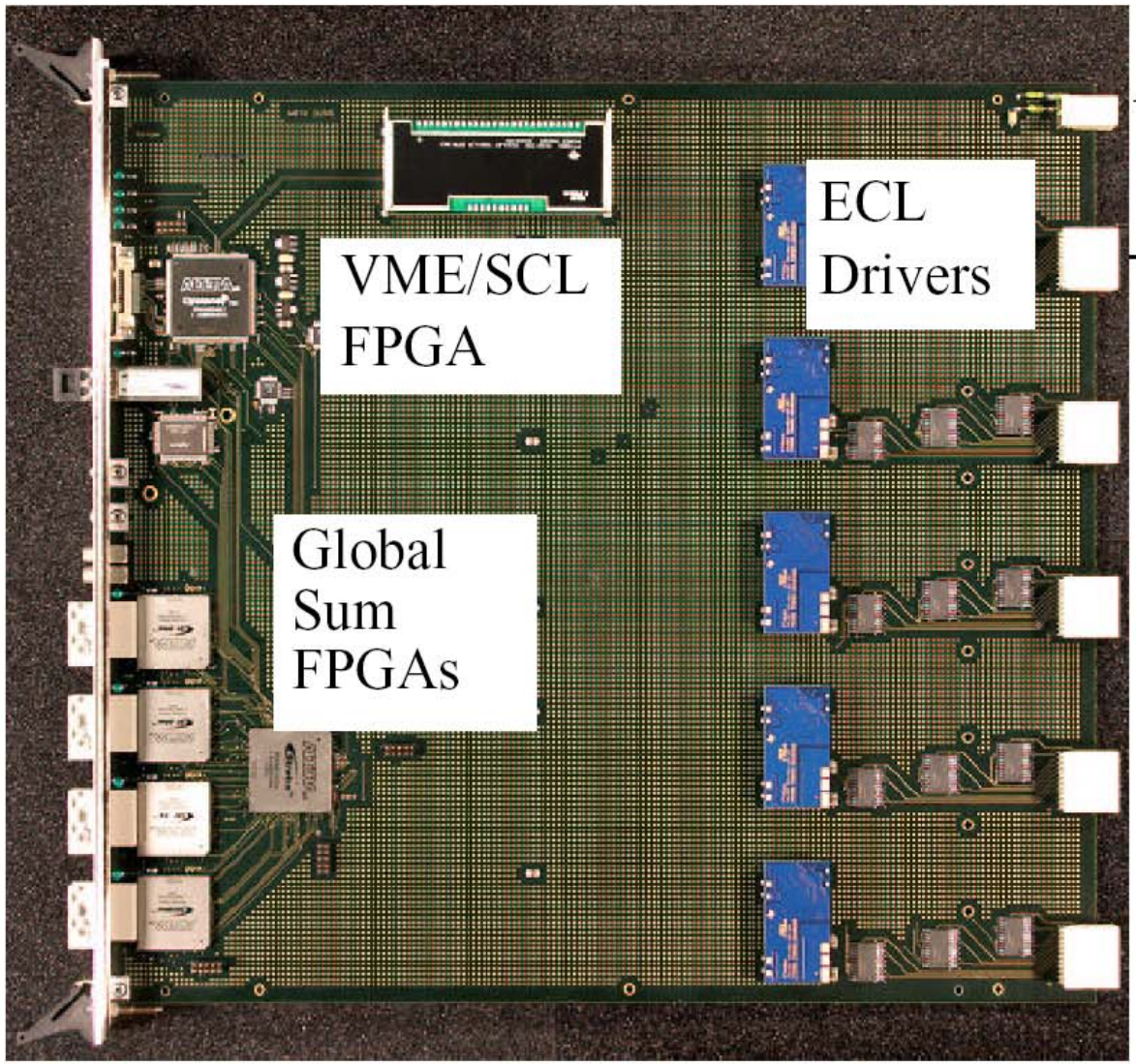
Test

Power

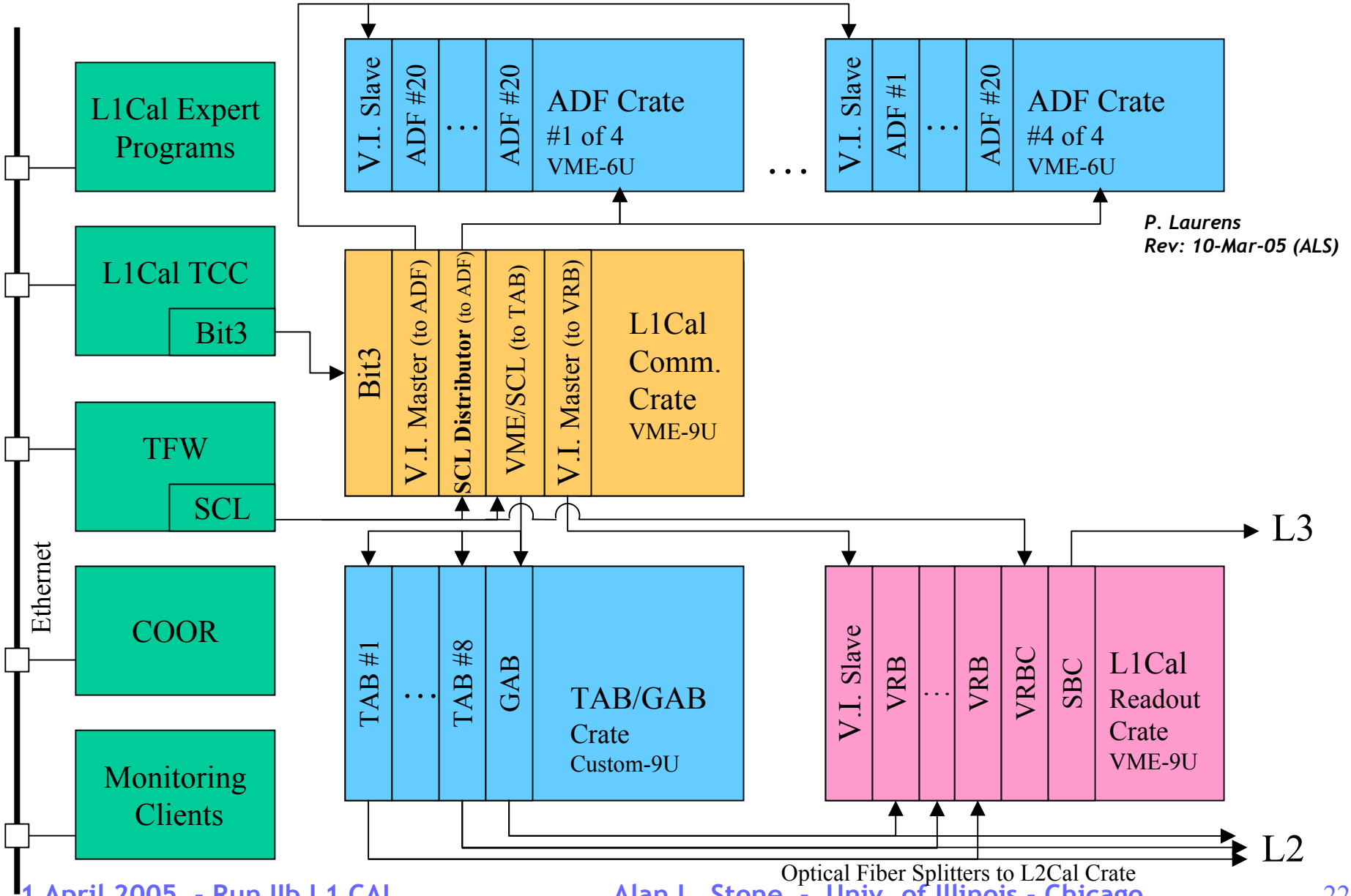
ADF Input

240 Low Voltage Differential Signal (LVDS) cables from the ADF backplane

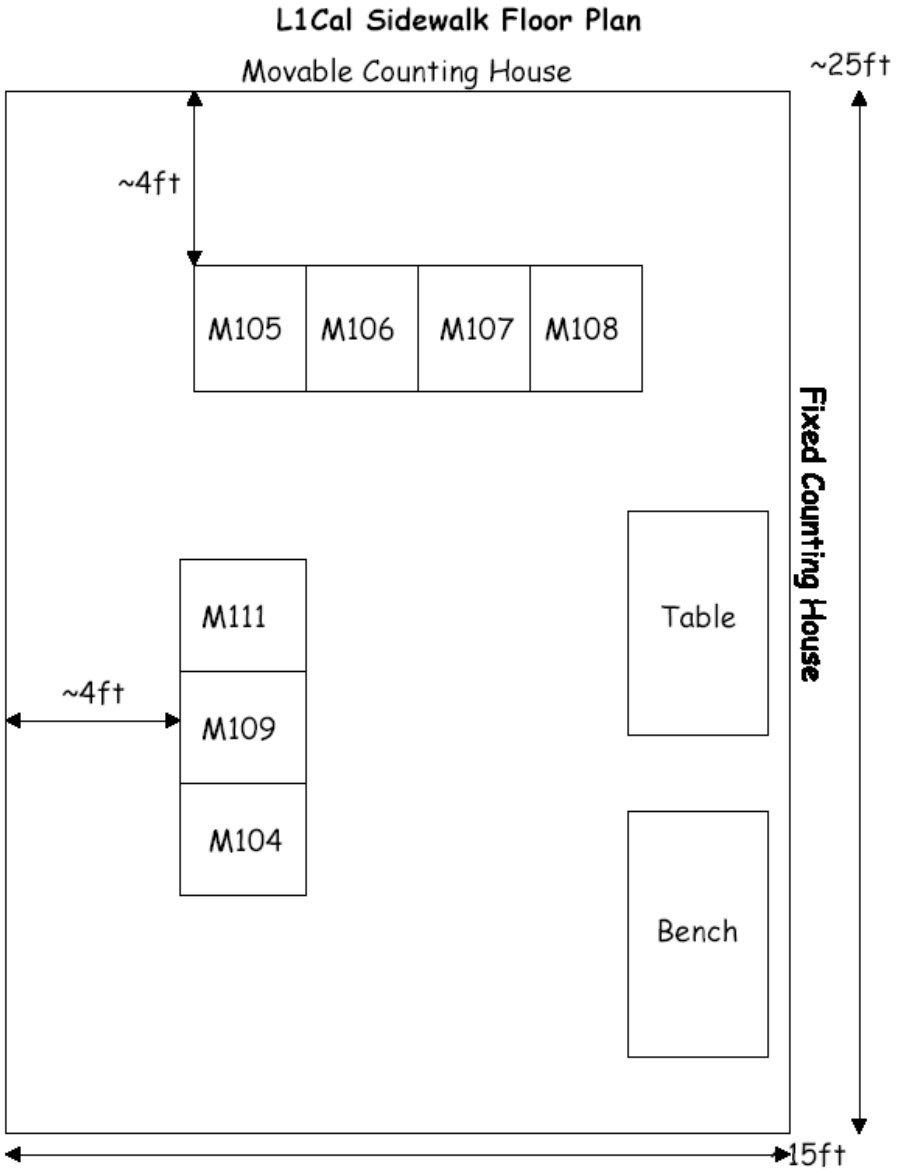
Global Algorithm Board (x1)



Run IIb L1 Calorimeter Trigger Control Path



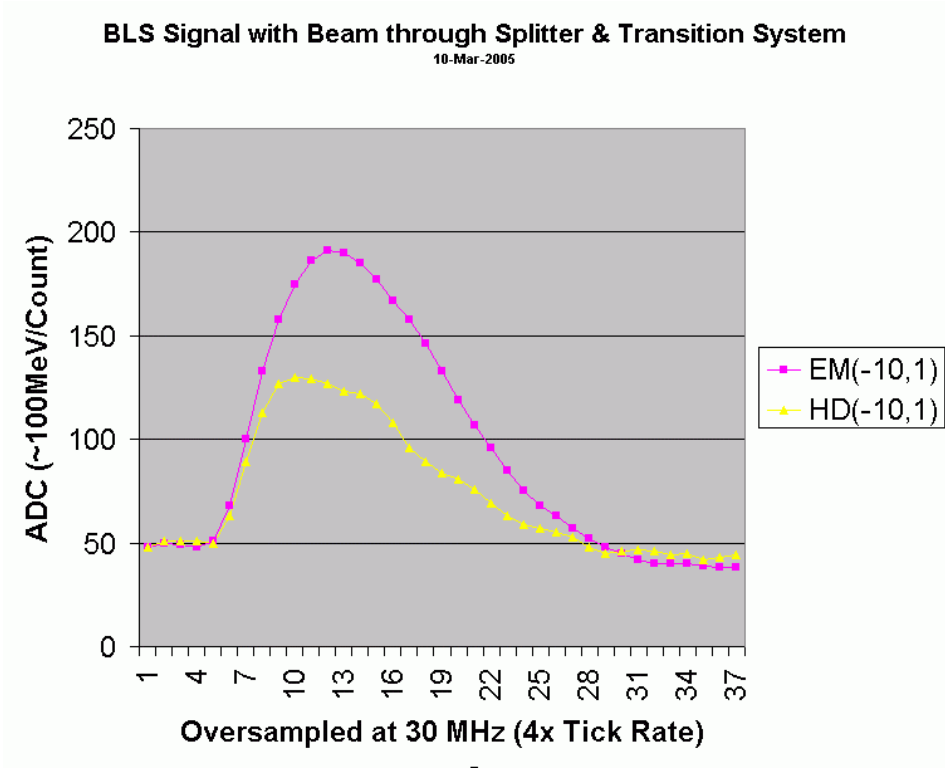
Sidewalk Test Stand



- Wooden platform adjacent to MCH1 near DAB pit
  - Isolated from building ground
- Establish a vertical slice of the final Run IIb L1 CAL Trigger system
  - All racks with active components have been built
    - ADF, TAB/GAB, Readout, Communications
  - Subset of transition system
  - Online computer, trigger control computer
  - Safety system for 24/7 power

Real BLS Signals

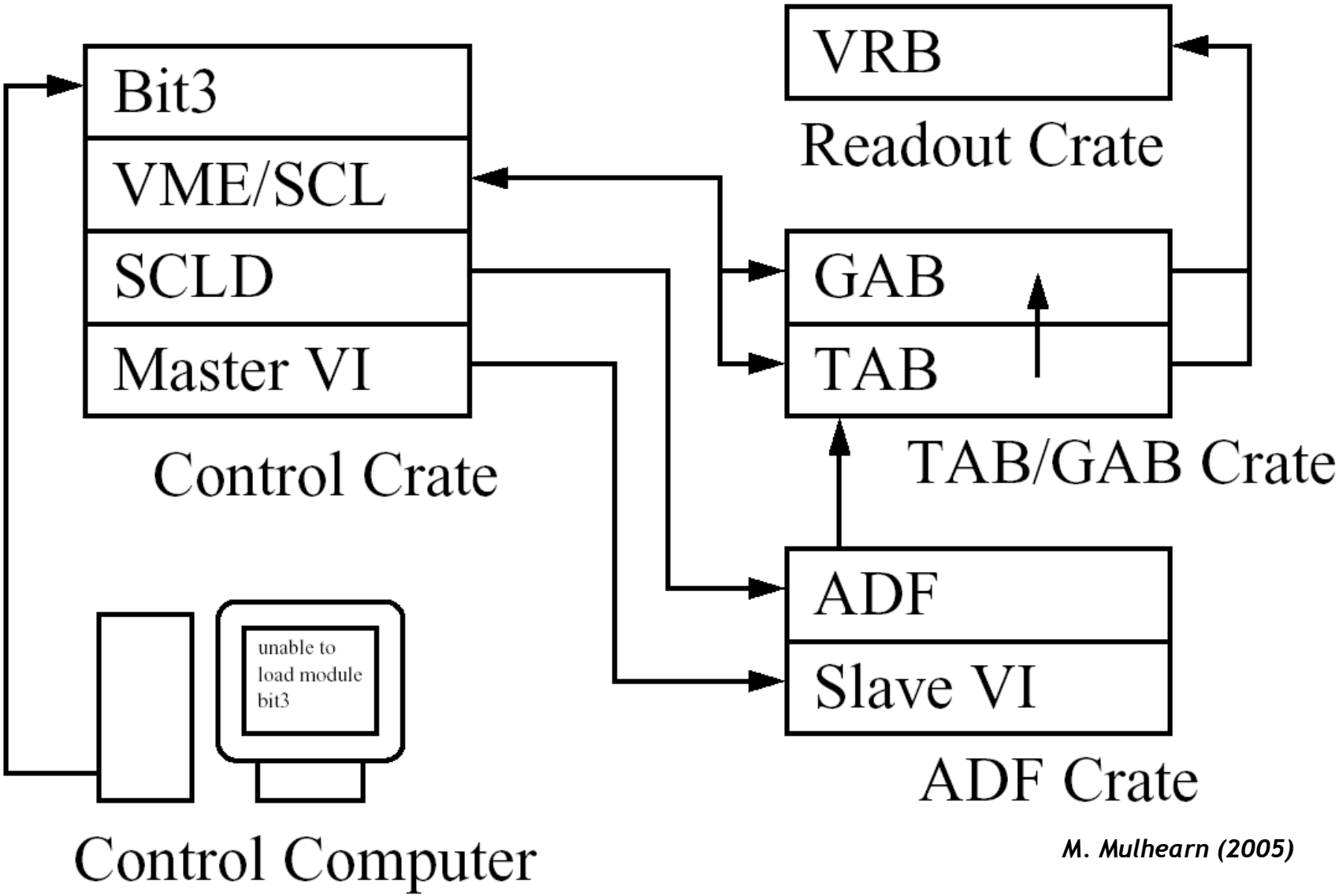
- During the Tevatron store on 10 Mar 2005, we were able to put some real BLS signals all the way through the cabling system & ADF card
- The BLS signal was split in MCH1, and a copy was sent over an additional run of BLS ribbon coaxial cable to the sidewalk
- The ribbon coaxial cable terminates in the same connector as is used in MCH1 (i.e. it looks just like a real BLS cable from the Platform). This connector plugs into BLS-to-ADF Transition System:
  - Patch Panel Card to Pleated Foil Cable to Paddle Card to ADF Crate Backplane
- In the ADF card the signal goes through some analog processing and is then digitized with a 10 bit sample taken every 33 nsec (4x the 132 nsec clock rate). Except for the added step of splitting the signal, this signal path, analog processing, and digitization scheme are exactly the same as will be used when the ADF is performing its function in the Run IIb L1 Calorimeter Trigger.



Completed Tests

- Extensive bench tests of all boards
- Interface tests
  - VME/SCL → TAB/GAB and TAB → GAB (Nevis)
  - SCLD → ADF (MSU)
  - ADF → TAB using SCL timing (Fermilab)
  - TAB → L1 Muon (Arizona)
- All firmware exists, and has been tested, except:
  - Digital filter algorithms
  - New EM algorithm (under development)
  - And/Or term creation (being tested)
  - GAB to L2 and L3

Integration of Components



M. Mulhearn (2005)

Hardware & Firmware Tests

- What can be tested?
- Stage 1
  - Fake data loaded into ADFs is received by TABs
  - Full speed tests for bit error rate
  - Add multiple ADF cards & channels
  - Add multiple TABs
- Stage 2
  - TAB/GAB to L2/L3 (tape)
  - BLS to ADF
  - GAB to Trigger Framework
  - TAB to L1 Muon
- Stage 3
  - To be discussed in future mtgs

- What do we have?
  - 3 ADF Crate + PS
    - VI Slave & 1+ ADF Boards
  - TAB Crate + PS
    - 1 + TABs, 1 GAB
  - Communication Crate + PS
    - Bit3 Card, VME/SCL Card, SCLD, 1 VI Master
  - Readout Crate + PS
    - VRBC, VRB, SBC
  - Cables
    - Also detailed mapping and labelling scheme
  - RMI with safety interlocks
    - Docs & review pending

Preparations for L3 Readout

Date: Wed, 09 Mar 2005 12:40:36 -0500 (EST)
From: Dan Edmunds <edmunds@pa.msu.edu>
To: scott snyder <snyder@fnal.gov>
Cc: Alan L. Stone <alstone@fnal.gov>, Philippe Laurens <laurens@pa.msu.edu>
Subject: New G.S. for Run 2B L1 Cal Trig tests

Hello Scott,

We would like to add 3 new Geographic Sections for the Run 2B
L1 Cal Trig tests that are taking place out on the sidewalk next
to the MCH. Can you edit the COOR Resource file to now include:

Crate Name	Readout or non-Readout	Geographic Section Number	Location - Comment
test_l1cal_readout	Readout	0x2D	VRBC in readout crate
test_l1cal_scld	NR	0x2E	SCLD in Comm. Crate
test_l1cal_tab	NR	0x2F	VME/SCL in Comm. Crate

None of these new Geographic Sections needs download from COMICS.
I believe that this is indicated by: type = Null_Device

Only one of these new G.S. reads out to L3 - the other 2 G.S. are
just involved with getting the data to the readout crate.

Alan and I picked longer "Crate Names" for these new G.S. than what
has been the custom in the past. We assumed that was OK with COOR.
We wanted names that were descriptive enough to avoid any confusion
between the current running system and these new tests.

Thank you, Dan

Scott has implemented the changes to COOR.

All three SCL cables have been run to the sidewalk test stand.

Sent a request to TMs and RCs for a special trigger list for just the test_l1cal_readout. Still waiting, but to be fair, we are not yet ready…

Local Organization

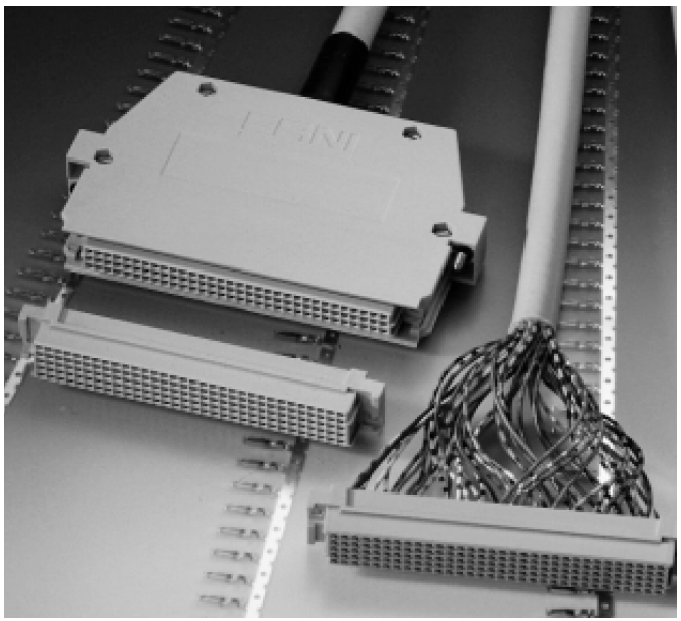
- Linda Bagby and Dan Edmunds are the co-leaders of the L1Cal Upgrade Installation.
- Sabine Lammers and Alan Stone are responsibile for the overall coordination of the commissioning of the hardware and on-line software of the L1Cal trigger, including the integration of the system for physics data taking.
- Mike Mulhearn is the L1Cal Test Stand Coordinator, and he will coordinate the pre-installation activities related to board, crate and system integration tests at the test stand on the sidewalk.
- John Fogelsong, Johnny Green, John Anderson and Marvin Johnson provide engineering and technical support.
- Mikolaj Cwiok, Md Naimuddin, Peter Renkel and Rahmi Unalan have recently joined the L1 CAL Integration effort.

- Weekly integration mtgs on Wed at 4-5 pm in Salle des Heroes
- Alan, Sabine, Mike and Linda will report to the Ops Mtg on a quasi-rotating schedule
  - Will give notice to Bill & Taka

That's it for now.
Hopefully this overview gives you some broad understanding of what we are doing. Be prepared for future reports heavily flavored with "BLS, ADF, TAB and GAB".

Paddle Cards

- Paddle card receives two inputs from pleated foil cables
- ERNI connector mates to ADF backplane - 20 paddle cards per ADF crate
- 3 Prototypes were made



- As a consequence of the ADF-2 Review six weeks ago, the panel recommended a redesign of the BLS-to-ADF Transition Paddle Card System
  - No guiderails for the paddle card
  - The congestion of cables in a 6-u backplane

Hinged Patch Panel (x40)